POSITIONS AND AREAS OF SUN SPOTS—Continued

| Date | Eastern standard time | Mt. Wilson group No. | Heliographic | | | Area | | Spot count | Observatory |
|---|---|---|---|---|---|---|---|---|---|
| | | | Diff. in longitude | Longitude | Latitude | Spot or group | Total for each day | | |
| *1938* | *h m* | | ° | ° | ° | | | | |
| Aug. 26 | 11 17 | 6071 | +2.0 | 198.2 | +9.5 | 12 | | 1 | U. S. Naval. |
| | | 6081 | +4.0 | 200.2 | −27.0 | 6 | | 3 | |
| | | 6070 | +12.0 | 208.2 | −22.0 | 12 | | 2 | |
| | | 6080 | +23.0 | 219.2 | −20.0 | 12 | | 3 | |
| | | 6079 | +23.0 | 219.2 | +24.0 | 12 | | 4 | |
| | | 6074 | +42.0 | 238.2 | −19.5 | 194 | | 33 | |
| | | 6059 | +66.0 | 262.2 | +2.0 | 12 | | 2 | |
| | | 6054 | +85.0 | 281.2 | +9.5 | 12 | 665 | 1 | |
| Aug. 27 | 10 59 | 6084 | −82.0 | 101.2 | +13.0 | 121 | | 5 | Do. |
| | | 6082 | −48.5 | 134.7 | −18.0 | 36 | | 4 | |
| | | 6078 | −47.0 | 136.2 | +27.5 | 97 | | 12 | |
| | | 6077 | −16.0 | 167.2 | +12.0 | 121 | | 17 | |
| | | 6081 | +12.0 | 195.2 | −26.0 | 6 | | 1 | |
| | | 6071 | +14.0 | 197.2 | +10.0 | 6 | | 1 | |
| | | 6070 | +25.0 | 208.2 | −21.0 | 16 | | 2 | |
| | | 6074 | +54.5 | 237.7 | −18.0 | 242 | 645 | 18 | |
| Aug. 28 | 11 6 | 6090 | −88.0 | 81.9 | −14.0 | 242 | | 2 | Do. |
| | | 6089 | −85.0 | 84.9 | −6.0 | 6 | | 1 | |
| | | 6088 | −82.0 | 87.9 | +14.0 | 194 | | 1 | |
| | | 6084 | −74.0 | 95.9 | +13.0 | 485 | | 14 | |
| | | 6087 | −66.0 | 103.9 | −22.5 | 12 | | 2 | |
| | | 6086 | −45.0 | 124.9 | −15.0 | 12 | | 3 | |
| | | 6082 | −38.0 | 131.9 | −20.5 | 6 | | 2 | |
| | | 6078 | −35.0 | 134.9 | +28.0 | 145 | | 11 | |
| | | 6077 | −3.0 | 166.9 | +13.0 | 145 | | 14 | |
| | | 6070 | +38.0 | 207.9 | −21.0 | 12 | | 3 | |
| | | 6074 | +69.0 | 238.9 | −19.0 | 291 | 1,550 | 10 | |
| Aug. 29 | 11 3 | 6092 | −76.0 | 80.7 | +17.0 | 48 | | 3 | Do. |
| | | 6090 | −70.0 | 86.7 | −15.0 | 194 | | 1 | |
| | | 6089 | −70.0 | 86.7 | −7.0 | 36 | | 1 | |
| | | 6088 | −68.0 | 88.7 | +14.0 | 194 | | 5 | |

POSITIONS AND AREAS OF SUN SPOTS—Continued

| Date | Eastern standard time | Mt. Wilson group No. | Heliographic | | | Area | | Spot count | Observatory |
|---|---|---|---|---|---|---|---|---|---|
| | | | Diff. in longitude | Longitude | Latitude | Spot or group | Total for each day | | |
| *1938* | *h m* | | ° | ° | ° | | | | |
| Aug. 29 | 11 3 | 6084 | −58.0 | 93.7 | +13.0 | 727 | | 25 | U. S. Naval. |
| | | 6087 | −50.0 | 106.7 | −21.0 | 6 | | 4 | |
| | | 6086 | −32.0 | 124.7 | −15.0 | 36 | | 5 | |
| | | 6078 | −25.0 | 131.7 | +29.0 | 61 | | 15 | |
| | | 6082 | −25.0 | 131.7 | −20.5 | 6 | | 2 | |
| | | 6077 | +10.0 | 166.7 | +12.5 | 48 | | 12 | |
| | | 6085 | +35.0 | 192.7 | +9.5 | 12 | | 2 | |
| | | 6074 | +80.0 | 236.7 | −19.0 | 145 | 1,513 | 3 | |
| Aug. 30 | 11 1 | 6093 | −80.0 | 63.5 | +11.0 | 24 | | 2 | Do. |
| | | 6092 | −62.0 | 81.5 | +17.0 | 36 | | 2 | |
| | | 6090 | −56.0 | 87.5 | −16.0 | 242 | | 12 | |
| | | 6089 | −55.0 | 88.5 | −7.0 | 12 | | 1 | |
| | | 6088 | −54.0 | 89.5 | +14.0 | 145 | | 4 | |
| | | 6084 | −45.0 | 98.5 | +13.0 | 485 | | 23 | |
| | | 6087 | −37.0 | 106.5 | −22.0 | 73 | | 14 | |
| | | 6086 | −19.5 | 124.0 | −17.0 | 36 | | 6 | |
| | | 6086 | −15.0 | 128.5 | −13.5 | 12 | | 2 | |
| | | 6078 | −12.5 | 131.0 | +28.5 | 73 | | 6 | |
| | | 6077 | +26.0 | 169.5 | +12.5 | 6 | 1,144 | 2 | |
| Aug. 31 | 11 6 | 6093 | −68.0 | 62.3 | +11.0 | 121 | | 10 | Do. |
| | | 6092 | −49.0 | 81.3 | +17.0 | 16 | | 2 | |
| | | 6090 | −42.0 | 88.3 | −16.0 | 388 | | 9 | |
| | | 6088 | −41.0 | 89.3 | +14.0 | 97 | | 6 | |
| | | 6089 | −41.0 | 89.3 | −6.5 | 12 | | 2 | |
| | | 6084 | −32.0 | 98.3 | +13.0 | 485 | | 33 | |
| | | 6087 | −23.0 | 107.3 | −21.5 | 24 | | 9 | |
| | | 6086 | −5.0 | 125.3 | −16.0 | 36 | | 8 | |
| | | 6078 | 0.0 | 130.3 | +29.0 | 36 | | 5 | |
| | | 6078 | +8.0 | 138.3 | +27.0 | 12 | 1,227 | 4 | |

Mean daily area for 31 days = 1,584. • Not numbered.

# AEROLOGICAL OBSERVATIONS

[Aerological Division, D. M. LITTLE in charge]

By B. FRANCIS DASHIELL

The mean free-air data for the month of August 1938, given in tables 1 and 1a, are based on a total of 410 airplane and 214 radiometeorograph observations, respectively. They include the basic meteorological elements of pressure, temperature, and relative humidity, recorded at standard geometric heights. August marked the inauguration of new radiometeorograph stations, and these high-altitude observations are shown in table 1a.

These "means" are computed by the customary method of differences, and are omitted whenever less than 15 observations are made at the surface, and less than 5 at a standard height. For those levels that fall within the limits of the monthly vertical range of the tropopause, at least 15 observations are required. In the January 1938 issue of the MONTHLY WEATHER REVIEW, under "Aerological Observations," the reader will find further details of such computations.

The departures of mean *surface* temperature from the normal during August are shown on chart 1. The month was characterized by a persistence of decidedly warm weather throughout the country, except west of the Continental Divide. The mean temperature was considerably above the normal in the Central States, and it reached a departure of +9° F. over southeastern Nebraska. The remainder of the Central Plains and Mississippi Valley, Ohio Valley, and Middle and North Atlantic States, were also warmer than normal with departures ranging from +2° F. to +6° F.

During August mean free-air temperatures were highest over the Gulf and Southeastern States at 0.5 kilometer, and over the Southwest at all other levels. Although mean surface temperatures during August were unusually high, the mean temperatures *above* the surface showed, in most all cases, only moderate increases over the preceding month of July. On the other hand, however, mean upper-air temperatures for the current month generally were lower at all levels than during the corresponding month of 1937. Greatest positive temperature differences for August over July were noted at 0.5 kilometer over San Diego, Calif. (2.8° C.); at 1 kilometer over Pensacola, Fla. (1.2° C.); at 1.5 and 2 kilometers over El Paso, Tex. (1.2° C. and 1.2° C., respectively); at 2.5 kilometers over Chicago, Ill. (1.5° C.); at 3 kilometers over Chicago, Ill., and Cheyenne, Wyo. (1.3° C.); at 4 kilometers over Cheyenne, Wyo., and Norfolk, Va. (1.2° C.); and at 5 kilometers over Norfolk, Va. (1.7° C.).

The free-air mean temperatures for August, over Seattle and Spokane, Wash., at all levels, were lower than in July. The greatest negative difference at Seattle, Wash., was 4.9° C. at 1.5 and 2 kilometers, while it was 3.5° C. over Spokane, Wash., at 2 kilometers. Negative temperature differences between August 1938 and August 1937 showed that the current month was cooler at most levels over the greater portion of the United States, with the exception of Seattle, Wash., Chicago, Ill., Norfolk, Va., and Pensacola, Fla., where August of this year was warmer.

The highest mean temperatures recorded at all levels were: 24.7° C. at Pensacola, Fla.; 25.3° C. (the highest for the country at any level) over Oklahoma City, Okla.; 23.2° C. and 20.4° C. over El Paso, Tex.; 17.6° C. and 13.7° C. over Salt Lake City, Utah; 6.0° C. over Salt Lake City, Utah, and Oklahoma City, Okla.; and −0.8° C. over Oklahoma City, Okla., at 0.5, 1, 1.5, 2, 2.5, 3, 4, and 5 kilometers, respectively. Low mean temperatures in the free air occurred over the Northwest at all levels, and

temperatures were relatively low over the Great Lakes and New England. The lowest for August (—7.8° C.) was recorded over Sault Ste. Marie, Mich., at 5 kilometers.

The lowest high-altitude temperature (—70.5° C.) was recorded over Washington, D. C., at 16 kilometers. Correspondingly low temperatures for August were found at 16 and 17 kilometers over stations also using radiometeorographs. The low temperatures recorded over stations which are farthest north, however, were somewhat higher than at points farther south but in the same high levels.

Isobaric charts, prepared from the pressure data given in tables 1 and 1a, for all levels up to 5 kilometers, showed that the mean free-air pressure for August over the central, southern, and eastern States, was higher than in July. But it was slightly lower elsewhere, and particularly so along a northern belt extending from Seattle, Wash., to Sault Ste. Marie, Mich. Pressure also was slightly lower over the entire country at all levels during August than in the corresponding month of 1937.

Pressure was high in August 1938 over the Southeast at all levels up to 2 kilometers, than over the southern half of the country east of the southern Rocky Mountain region up to 5 kilometers. Elsewhere the pressure was lower. A statistical low-pressure area appeared at 0.5, 1, and 1.5 kilometers over Fargo, N. Dak., and the northern Rocky Mountain region. At 2 kilometers this area had moved eastward to Sault Ste. Marie, Mich., but was practically nonexistent at 5 kilometers.

Free-air humidity was unevenly distributed over the country during August. The highest humidities recorded at the different levels were found over San Diego, Calif. (81 percent), Nashville, Tenn. (81 percent), and Sault Ste. Marie, Mich. (76 percent), at 0.5 kilometer; over Lakehurst, N. J., Nashville, Tenn., and Sault Ste. Marie, Mich., at 1, 1.5, and 2 kilometers; and over Nashville, Tenn., and Sault Ste. Marie, Mich., at 2.5, 3, 4, and 5 kilometers. Humidity was high over Seattle, Wash. (65 percent at 1 kilometer), up to 2 kilometers, but the air rapidly became much drier from that level (28 percent at 3 kilometers) up to 5 kilometers, inclusive.

In August the mean relative humidities were higher than those recorded during the preceding months of June and July. Over the far Northwest the humidity, up to 2 kilometers, was about 10 percent greater than in July, and from 10 to 20 percent higher in the South and East up to 4 kilometers, but lower over the entire country at 5 kilometers. It was noted, too, that while the areas of high humidity were concentrated over the South during July, they moved toward the North in August and occupied about the same position they did in June. Over Oakland, Calif., where the driest air in the United States was recorded up to 5 kilometers, high-altitude observations showed that the humidity was only 20 percent at 10 kilometers.

Resultant winds in the free atmosphere, based on pilot balloon observations made near 5 a. m. (75th meridian time) during the month of August, are given in table 2. The resultant-wind directions indicated definite departures from the normal almost everywhere, although during the preceding month of July the greatest departures were confined mostly to the southeastern States. As usual, large departures from normal directions were noted at the surface, and at Sault Ste. Marie, Mich., the current resultant wind direction was 100° south of its normal.

The differences between outstanding resultant-wind directions for August and their normals (in degrees), at all levels, were: 55° north of normal (when rotated in a clockwise direction) over Fargo, N. Dak.; 64° south of normal (when rotated counter-clockwise) over Pensacola, Fla.; 69° north of normal, over Seattle, Wash.; 54° north, over Medford, Oreg.; 57° north, over Salt Lake City, Utah; 70° south, and 44° north, over Oklahoma City, Okla.; and 68° south of normal, over Atlanta, Ga.; all at 0.5, 1, 1.5, 2, 2.5, 3, 4, and 5 kilometers, respectively.

Upper-air resultant wind directions over the United States, during August, showed that 77 percent were westerly and 23 percent had easterly components. The winds were found to be 20 percent easterly at 0.5 kilometers, and this ratio remained nearly constant up through all levels to 4 kilometers. At 5 kilometers, 25 percent of all directions showed easterly components. And, of all the easterly winds recorded at every level, the majority fell within the southeast quadrant, while those having westerly components were about equally divided between the northwest and southwest quadrants.

It is interesting to note that, during August, many pilot balloon stations reported resultant wind directions having departures that were south of normal, when rotated counterclockwise. Such southerly departures occurred at St. Louis, Mo., Chicago, Ill., Detroit, Mich., Sault Ste. Marie, Mich., Fargo, N. Dak., Omaha, Nebr., Oklahoma City, Okla., and Cheyenne, Wyo. These departures, it will be seen, were confined generally to an area that covered the entire central portion of the United States, and extended from the Gulf to the Canadian border. Since this condition existed at most levels, and can be compared with the high temperatures which persisted during August over the same area, it becomes significant. Resultant wind directions which were north of normal, at most levels, occurred over the Eastern and Western States where mean temperatures were considerably less than those recorded in the Central States.

At Key West, Fla., departures in resultant winds from normal were in a counter-clockwise direction as opposed to the situation that prevailed during July when wind directions at all levels over Key West departed from normal in a clockwise direction. But, at Pensacola, Fla., the August departures in direction were very similar to those noted in July, except that a clockwise departure occurred at 4 kilometers. Nashville, Tenn., was the only station in the country reporting departures that turned north of normal at all levels, while St. Louis, Mo., as in July, showed the most nearly normal wind directions at all levels in the United States.

Wind velocities for August were somewhat higher than normal over most of the United States at all levels up to 4 kilometers. Such was the case over all balloon stations at 1 kilometer, as well as at 1.5 kilometers, except over Seattle, Wash. Large positive departures from the normal resultant-wind velocity occurred over Key West, Fla., at 2, 2.5, 3, and 4 kilometers, and smaller positive departures over Fargo, N. Dak., and Detroit, Mich., at 1 kilometer, and over Sault Ste. Marie, Mich., at 2.5 and 3 kilometers. Negative departures of resultant velocity were slight whenever they occurred, except at Boston, Mass., where the velocity was 5.3 m. p. s. less than normal.

Table 3 shows the maximum winds recorded in August. A velocity of 69.8 m. p. s. (157 miles per hour) occurred from the SSW at 2.6 kilometers over Havre, Mont., on the 11th. Maximum winds elsewhere were not excessive, but in the very high levels a wind speed of 64.5 m. p. s. from the WSW was observed over Redding, Calif., at 24.7 kilometers.

TABLE 1.—*Mean free-air barometric pressures (P) in mb., temperatures (T) in ° C., and relative humidities (R. H.) in percent obtained by airplanes during August 1938*

| Stations and elevations in meters above sea level | Altitude (meters), m. s. l. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Surface | | | | 500 | | | 1,000 | | | 1,500 | | | 2,000 | | | 2,500 | | | 3,000 | | | 4,000 | | | 5,000 | | | | | |
| | Number of obs. | P | T | R. H. | P | T | R. H. | P | T | R. H. | P | T | R. H. | P | T | R. H. | P | T | R. H. | P | T | R. H. | P | T | R. H. | P | T | R. H. | | | |
| Billings, Mont. (1,090 m) | 30 | 892 | 17.4 | 51 | | | | | | | 850 | 20.3 | 41 | 802 | 17.3 | 40 | 756 | 13.6 | 43 | 712 | 9.7 | 48 | 630 | 2.1 | 56 | 556 | −4.9 | 58 | | | |
| Cheyenne, Wyo. (1,873 m) | 31 | 815 | 15.4 | 64 | | | | | | | | | | 803 | 17.5 | 56 | 757 | 16.5 | 50 | 714 | 13.2 | 48 | 633 | 5.4 | 52 | 559 | −3.2 | 62 | | | |
| Chicago, Ill. (187 m) | 31 | 994 | 20.4 | 85 | 960 | 22.1 | 70 | 906 | 19.9 | 71 | 855 | 17.2 | 69 | 806 | 15.0 | 63 | 759 | 12.2 | 57 | 715 | 9.2 | 53 | 633 | 2.9 | 51 | 559 | −3.0 | 45 | | | |
| Coco Solo, C. Z.[1] (15 m) | 25 | 1,009 | 24.2 | 94 | 955 | 23.3 | 84 | 902 | 20.6 | 82 | 850 | 18.1 | 79 | 802 | 15.5 | 78 | 756 | 13.4 | 68 | 712 | 10.7 | 66 | 630 | 4.7 | 72 | 558 | −0.8 | 70 | | | |
| El Paso, Tex. (1,193 m) | 31 | 883 | 21.8 | 54 | | | | | | | 853 | 23.2 | 46 | 805 | 20.4 | 47 | 759 | 16.6 | 52 | 716 | 12.5 | 58 | 634 | 4.5 | 66 | 560 | −2.8 | 68 | | | |
| Lakehurst, N. J.[1] (39 m) | 31 | 1,010 | 20.1 | 91 | 958 | 22.3 | 64 | 904 | 18.4 | 68 | 852 | 14.3 | 75 | 803 | 11.0 | 73 | 756 | 8.1 | 63 | 711 | 5.2 | 55 | 627 | −0.9 | 53 | | | | | | |
| Norfolk, Va.[1] (10 m) | 30 | 1,016 | 23.4 | 93 | 961 | 23.4 | 72 | 907 | 20.4 | 69 | 856 | 17.2 | 66 | 807 | 14.7 | 64 | 760 | 12.1 | 57 | 716 | 9.6 | 52 | 633 | 4.2 | 44 | 560 | −2.6 | 42 | | | |
| Pearl Harbor, T. H.[1] (6 m) | 31 | 1,014 | 23.4 | 85 | 959 | 22.3 | 80 | 904 | 19.2 | 83 | 853 | 16.5 | 82 | 804 | 14.3 | 76 | 757 | 13.4 | 60 | 713 | 12.3 | 43 | 632 | 8.0 | 35 | 560 | 3.2 | 34 | | | |
| Pensacola, Fla.[1] (13 m) | 29 | 1,017 | 23.7 | 94 | 962 | 24.7 | 69 | 909 | 21.8 | 61 | 857 | 18.4 | 61 | 809 | 15.3 | 55 | 761 | 12.0 | 56 | 717 | 9.0 | 54 | 634 | 3.1 | 51 | 560 | −2.4 | 48 | | | |
| St. Thomas, V. I.[1] (8 m) | 31 | 1,015 | 27.7 | 75 | 959 | 22.7 | 86 | 906 | 19.5 | 86 | 854 | 17.0 | 81 | 806 | 16.0 | 65 | 759 | 13.6 | 55 | 715 | 10.4 | 50 | 633 | 3.9 | 49 | 560 | −1.4 | 46 | | | |
| Salt Lake City, Utah (1,288 m) | 31 | 871 | 19.0 | 50 | | | | | | | 850 | 23.0 | 39 | 803 | 20.9 | 35 | 758 | 17.6 | 35 | 714 | 13.7 | 38 | 634 | 6.0 | 46 | 560 | −1.7 | 58 | | | |
| San Diego, Calif.[1] (10 m) | 29 | 1,013 | 19.2 | 86 | 957 | 18.1 | 81 | 903 | 22.6 | 51 | 852 | 22.5 | 38 | 804 | 20.1 | 36 | 758 | 16.6 | 37 | 714 | 12.7 | 38 | 633 | 4.9 | 44 | 559 | −2.4 | 51 | | | |
| Seattle, Wash.[1] (10 m) | 19 | 1,019 | 15.8 | 74 | 961 | 13.4 | 74 | 906 | 12.1 | 67 | 852 | 10.2 | 59 | 803 | 8.3 | 50 | 755 | 6.3 | 37 | 710 | 3.9 | 28 | 627 | −2.1 | 28 | | | | | | |
| Spokane, Wash. (597 m) | 31 | 945 | 13.4 | 57 | | | | 902 | 19.4 | 37 | 850 | 16.7 | 36 | 802 | 13.0 | 39 | 755 | 9.2 | 42 | 710 | 5.6 | 45 | 628 | −0.8 | 47 | 553 | −7.6 | 46 | | | |

Observations taken about 4 a. m. 75th meridian time, except by Navy stations along the Pacific coast and Hawaii, where they are taken at dawn.

[1] Navy.

NOTE.—None of the means included in this table are based on less than 15 surface or 5 standard-level observations.

TABLE 1a.—*Mean free-air barometric pressures (P) in mb., temperatures (T) in °C., and relative humidities (R. H.) in percent obtained by radiometeorographs during August 1938*

| Altitude (meters) m. s. l. | Stations and elevations in meters above sea level | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Fargo, N. Dak. (274 m) | | | | Nashville, Tenn. (180 m) | | | | Oakland, Calif. (2 m) | | | | Oklahoma City, Okla. (391 m) | | | | Omaha, Nebr. (300 m) | | | | Sault Ste. Marie, Mich. (221 m) | | | | Washington, D. C. (13 m) [1] | | | | | |
| | Number of obs. | P | T | R. H. | Number of obs. | P | T | R. H. | Number of obs. | P | T | R. H. | Number of obs. | P | T | R. H. | Number of obs. | P | T | R. H. | Number of obs. | P | T | R. H. | Number of obs. | P | T | R. H. | | |
| Surface | 31 | 979 | 17.7 | 73 | 31 | 996 | 22.1 | 91 | 31 | 1,014 | 14.1 | 85 | 31 | 970 | 23.5 | 71 | 31 | 979 | 22.1 | 80 | 31 | 988 | 15.1 | 93 | 29 | 1,016 | 21.3 | 88 | | |
| 500 | 31 | 954 | 20.7 | 65 | 31 | 960 | 23.1 | 81 | 31 | 957 | 15.1 | 74 | 31 | 958 | 24.4 | 67 | 31 | 958 | 22.8 | 72 | 31 | 957 | 16.9 | 84 | 29 | 960 | 21.9 | 73 | | |
| 1,000 | 31 | 900 | 20.6 | 56 | 31 | 907 | 21.1 | 76 | 31 | 902 | 20.4 | 45 | 31 | 905 | 25.3 | 57 | 31 | 904 | 22.7 | 62 | 31 | 902 | 16.0 | 76 | 29 | 907 | 19.4 | 71 | | |
| 1,500 | 31 | 850 | 18.1 | 53 | 31 | 856 | 18.3 | 72 | 31 | 852 | 19.8 | 34 | 31 | 855 | 22.8 | 55 | 31 | 854 | 21.4 | 58 | 31 | 850 | 12.9 | 77 | 29 | 854 | 15.9 | 71 | | |
| 2,000 | 31 | 801 | 15.0 | 51 | 31 | 807 | 15.1 | 67 | 31 | 803 | 17.6 | 29 | 31 | 807 | 19.5 | 56 | 31 | 806 | 18.5 | 54 | 31 | 800 | 9.8 | 74 | 29 | 806 | 12.7 | 69 | | |
| 2,500 | 31 | 755 | 11.6 | 51 | 31 | 760 | 12.0 | 65 | 31 | 757 | 14.8 | 27 | 31 | 761 | 16.4 | 57 | 31 | 760 | 15.1 | 56 | 31 | 754 | 7.4 | 71 | 28 | 758 | 9.5 | 68 | | |
| 3,000 | 31 | 711 | 7.9 | 52 | 31 | 716 | 8.6 | 62 | 31 | 713 | 11.7 | 27 | 31 | 718 | 12.9 | 56 | 31 | 716 | 11.6 | 55 | 31 | 709 | 4.4 | 69 | 28 | 714 | 6.8 | 64 | | |
| 4,000 | 29 | 629 | 0.4 | 55 | 31 | 634 | 2.3 | 58 | 31 | 632 | 4.2 | 26 | 31 | 636 | 6.0 | 50 | 31 | 634 | 3.3 | 55 | 31 | 626 | −1.7 | 61 | 28 | 631 | 1.4 | 58 | | |
| 5,000 | 29 | 554 | −6.8 | 56 | 31 | 560 | −3.7 | 55 | 31 | 558 | −2.9 | 27 | 31 | 562 | −0.8 | 44 | 31 | 560 | −3.9 | 58 | 30 | 552 | −7.8 | 57 | 27 | 557 | −4.5 | 53 | | |
| 6,000 | 29 | 487 | −13.2 | 52 | 31 | 493 | −9.1 | 50 | 31 | 491 | −9.3 | 24 | 31 | 495 | −7.0 | 40 | 30 | 492 | −10.8 | 56 | 28 | 485 | −14.2 | 54 | 27 | 489 | −10.5 | 48 | | |
| 7,000 | 28 | 426 | −20.5 | 48 | 31 | 432 | −15.5 | 44 | 30 | 430 | −16.9 | 22 | 31 | 435 | −13.8 | 36 | 30 | 432 | −17.7 | 51 | 26 | 424 | −21.4 | 49 | 27 | 429 | −17.4 | 45 | | |
| 8,000 | 28 | 372 | −27.7 | 46 | 30 | 378 | −22.2 | 41 | 30 | 377 | −24.5 | 21 | 31 | 380 | −21.2 | 34 | 30 | 377 | −24.2 | 48 | 26 | 370 | −28.6 | 48 | 25 | 374 | −24.4 | 43 | | |
| 9,000 | 27 | 322 | −35.1 | 44 | 30 | 329 | −29.7 | 38 | 29 | 327 | −32.6 | 20 | 31 | 332 | −28.8 | 33 | 29 | 328 | −31.6 | 46 | 23 | 320 | −36.2 | 47 | 25 | 326 | −31.7 | 41 | | |
| 10,000 | 27 | 279 | −42.6 | ---- | 30 | 285 | −37.7 | 37 | 28 | 284 | −40.6 | 20 | 31 | 288 | −36.4 | 33 | 29 | 284 | −39.4 | 45 | 22 | 277 | −43.1 | 46 | 24 | 282 | −39.4 | ---- | | |
| 11,000 | 27 | 240 | −49.5 | ---- | 29 | 246 | −45.1 | ---- | 27 | 244 | −46.9 | ---- | 31 | 248 | −44.0 | ---- | 29 | 245 | −46.5 | ---- | 21 | 238 | −48.8 | 46 | 24 | 243 | −47.1 | ---- | | |
| 12,000 | 27 | 206 | −55.3 | ---- | 29 | 212 | −52.3 | ---- | 26 | 210 | −52.6 | ---- | 31 | 214 | −50.3 | ---- | 29 | 210 | −53.3 | ---- | 20 | 204 | −53.1 | 44 | 24 | 209 | −54.8 | ---- | | |
| 13,000 | 26 | 175 | −59.3 | ---- | 29 | 180 | −59.3 | ---- | 25 | 179 | −56.8 | ---- | 30 | 183 | −56.9 | ---- | 28 | 180 | −59.3 | ---- | 18 | 175 | −56.4 | ---- | 22 | 178 | −61.2 | ---- | | |
| 14,000 | 25 | 150 | −61.2 | ---- | 29 | 154 | −65.0 | ---- | 24 | 153 | −60.0 | ---- | 30 | 156 | −62.5 | ---- | 27 | 153 | −63.8 | ---- | 18 | 149 | −59.0 | ---- | 19 | 151 | −66.4 | ---- | | |
| 15,000 | 21 | 127 | −62.9 | ---- | 25 | 130 | −68.4 | ---- | 18 | 130 | −63.0 | ---- | 20 | 132 | −66.4 | ---- | 20 | 130 | −67.7 | ---- | 11 | 127 | −60.6 | ---- | 13 | 128 | −69.1 | ---- | | |
| 16,000 | 14 | 108 | −63.7 | ---- | 19 | 110 | −69.8 | ---- | 8 | 110 | −64.1 | ---- | 13 | 112 | −68.7 | ---- | 17 | 110 | −69.5 | ---- | 8 | 108 | −61.8 | ---- | 5 | 108 | −70.5 | ---- | | |
| 17,000 | 7 | 92 | −63.4 | ---- | 12 | 94 | −70.3 | ---- | ------ | ------ | ------ | ---- | 10 | 95 | −69.1 | ---- | ------ | ------ | ------ | ---- | ------ | ------ | ------ | ---- | ------ | ------ | ------ | ---- | | |
| 18,000 | ------ | ------ | ------ | ---- | 8 | 79 | −69.4 | ---- | ------ | ------ | ------ | ---- | 9 | 80 | −67.8 | ---- | ------ | ------ | ------ | ---- | ------ | ------ | ------ | ---- | ------ | ------ | ------ | ---- | | |
| 19,000 | ------ | ------ | ------ | ---- | 8 | 67 | −68.3 | ---- | ------ | ------ | ------ | ---- | 9 | 68 | −66.8 | ---- | ------ | ------ | ------ | ---- | ------ | ------ | ------ | ---- | ------ | ------ | ------ | ---- | | |
| 20,000 | ------ | ------ | ------ | ---- | 8 | 57 | −66.1 | ---- | ------ | ------ | ------ | ---- | 6 | 58 | −65.3 | ---- | ------ | ------ | ------ | ---- | ------ | ------ | ------ | ---- | ------ | ------ | ------ | ---- | | |
| 21,000 | ------ | ------ | ------ | ---- | 5 | 48 | −65.0 | ---- | ------ | ------ | ------ | ---- | 5 | 49 | −62.9 | ---- | ------ | ------ | ------ | ---- | ------ | ------ | ------ | ---- | ------ | ------ | ------ | ---- | | |

Observations taken about 4 a. m. 75th meridian time, except by Navy stations along the Pacific coast and Hawaii where they are taken at dawn.

[1] Navy.

NOTE.—None of the means included in this table are based on less than 15 surface or 5 standard-level observations.
Number of observations refers to pressure only as temperature and humidity data are missing for some observations at certain levels also the humidity data are not used where daily temperature readings were below −40° C.

TABLE 2.—*Free-air resultant winds (meters per second) based on pilot-balloon observations made near 5 a. m. (E. S. T.) during August 1938*

[Wind from N=360°, E=90°, etc.]

| Altitude (meters) m. s. l. | Albuquerque, N. Mex. (1,554 m) | | Atlanta, Ga. (309 m) | | Billings, Mont. (1,095 m) | | Boston, Mass. (15 m) | | Cheyenne, Wyo. (1,873 m) | | Chicago, Ill. (192 m) | | Cincinnati, Ohio (157 m) | | Detroit, Mich. (204 m) | | Fargo, N. Dak. (283 m) | | Houston, Tex. (21 m) | | Key West, Fla. (11 m) | | Medford, Oreg. (410 m) | | Nashville, Tenn. (194 m) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Direction | Velocity | Direction | Velocity | Direction | Velocity | Direction | Velocity | Direction | Velocity | Direction | Velocity | Direction | Velocity | Direction | Velocity | Direction | Velocity | Direction | Velocity | Direction | Velocity | Direction | Velocity | Direction | Velocity |
| | ° | | ° | | ° | | ° | | ° | | ° | | ° | | ° | | ° | | ° | | ° | | ° | | ° | |
| Surface | 16 | 0.6 | 289 | 1.4 | 260 | 1.5 | 274 | 2.0 | 276 | 2.4 | 210 | 1.1 | 96 | 0.5 | 262 | 1.8 | 198 | 1.0 | 70 | 0.4 | 95 | 3.6 | 181 | 0.5 | 220 | 0.9 |
| 500 | ------ | ----- | 284 | 3.3 | ------ | ----- | 307 | 4.8 | ------ | ----- | 227 | 4.9 | 234 | 2.4 | 270 | 4.2 | 231 | 2.9 | 178 | 5.2 | 101 | 7.7 | 273 | .8 | 237 | 3.8 |
| 1,000 | ------ | ----- | 300 | 3.3 | ------ | ----- | 308 | 4.6 | ------ | ----- | 250 | 4.4 | 258 | 3.7 | 271 | 6.1 | 251 | 7.1 | 157 | 5.7 | 105 | 7.4 | 306 | 1.5 | 265 | 4.7 |
| 1,500 | ------ | ----- | 298 | 3.2 | 249 | 1.9 | 295 | 5.0 | ------ | ----- | 264 | 5.5 | 268 | 4.0 | 270 | 7.2 | 253 | 7.3 | 146 | 5.4 | 102 | 6.7 | 335 | .5 | 282 | 4.3 |
| 2,000 | 184 | 2.2 | 296 | 3.2 | 248 | 2.2 | 287 | 5.9 | 273 | 3.8 | 277 | 6.0 | 277 | 4.1 | 282 | 6.5 | 284 | 8.5 | 137 | 5.2 | 94 | 6.7 | 208 | .4 | 298 | 4.2 |
| 2,500 | 230 | 2.2 | 310 | 3.2 | 252 | 3.2 | 294 | 6.9 | 246 | 4.1 | 281 | 6.5 | 280 | 4.2 | 293 | 7.4 | 270 | 8.6 | 139 | 4.5 | 91 | 6.9 | 234 | 3.5 | 298 | 4.9 |
| 3,000 | 237 | 3.2 | 316 | 2.8 | 259 | 5.6 | 295 | 7.6 | 253 | 3.9 | 289 | 7.0 | 291 | 6.0 | 303 | 8.9 | 284 | 9.3 | 128 | 4.1 | 96 | 6.5 | 229 | 5.1 | 315 | 4.3 |
| 4,000 | 220 | 2.4 | 306 | 1.8 | 260 | 9.1 | ------ | ----- | 254 | 5.9 | 325 | 8.6 | 313 | 5.6 | 315 | 9.1 | 276 | 11.3 | 106 | 3.5 | 85 | 5.3 | 236 | 5.8 | 291 | 2.8 |
| 5,000 | 136 | 1.2 | 218 | .9 | 278 | 10.2 | ------ | ----- | 243 | 9.9 | ------ | ----- | ------ | ----- | 307 | 9.4 | ------ | ----- | 103 | 4.0 | ------ | ----- | 257 | 6.5 | ------ | ----- |

| Altitude (meters) m. s. l. | Newark, N. J. (14 m) | | Oakland, Calif. (8 m) | | Oklahoma City, Okla. (402 m) | | Omaha, Nebr. (306 m) | | Pearl Harbor, Territory of Hawaii [1] (68 m) | | Pensacola, Fla. [1] (24 m) | | St. Louis, Mo. (170 m) | | Salt Lake City, Utah (1,292 m) | | San Diego, Calif. (15 m) | | Sault Ste. Marie, Mich. (198 m) | | Seattle, Wash. (14 m) | | Spokane, Wash. (603 m) | | Washington, D. C. (10 m) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Direction | Velocity | Direction | Velocity | Direction | Velocity | Direction | Velocity | Direction | Velocity | Direction | Velocity | Direction | Velocity | Direction | Velocity | Direction | Velocity | Direction | Velocity | Direction | Velocity | Direction | Velocity | Direction | Velocity |
| | ° | | ° | | ° | | ° | | ° | | ° | | ° | | ° | | ° | | ° | | ° | | ° | | ° | |
| Surface | 269 | 1.3 | 243 | 1.0 | 175 | 4.9 | 160 | 2.6 | ------ | ----- | 288 | 0.2 | 198 | 1.0 | 148 | 3.4 | 2 | 1.1 | 268 | 0.5 | 138 | 0.8 | 68 | 1.4 | 267 | 0.6 |
| 500 | 287 | 5.3 | 269 | 2.1 | 187 | 7.9 | 178 | 5.7 | ------ | ----- | 232 | .5 | 219 | 4.1 | ------ | ----- | 346 | 2.2 | 260 | 3.1 | 42 | 1.8 | ------ | ----- | 287 | 4.6 |
| 1,000 | 302 | 5.7 | 306 | 4.8 | 210 | 13.8 | 219 | 8.2 | ------ | ----- | 138 | 1.5 | 249 | 5.4 | ------ | ----- | 339 | 1.8 | 282 | 5.5 | 45 | 1.7 | 232 | 3.0 | 304 | 5.2 |
| 1,500 | 296 | 5.3 | 281 | 3.1 | 213 | 9.1 | 232 | 6.8 | ------ | ----- | 153 | .9 | 266 | 6.0 | 156 | 4.7 | 318 | .6 | 297 | 6.4 | 45 | .5 | 238 | 3.9 | 299 | 4.9 |
| 2,000 | 306 | 6.3 | 251 | 3.7 | 216 | 4.8 | 244 | 6.0 | ------ | ----- | 108 | .4 | 273 | 5.8 | 181 | 4.1 | 162 | 1.1 | 298 | 8.1 | 304 | 1.3 | 232 | 4.9 | 296 | 6.1 |
| 2,500 | 303 | 7.1 | 237 | 4.2 | 207 | 2.9 | 260 | 5.5 | ------ | ----- | 96 | .6 | 268 | 4.5 | 210 | 3.9 | 150 | 3.0 | 290 | 9.8 | 302 | 1.4 | 239 | 5.9 | 294 | 6.8 |
| 3,000 | 307 | 6.2 | ------ | ----- | 159 | 2.3 | 286 | 5.2 | ------ | ----- | 47 | 1.8 | 279 | 3.8 | 234 | 4.1 | 134 | 4.6 | 278 | 10.4 | 281 | 4.8 | 244 | 7.4 | 289 | 6.8 |
| 4,000 | 302 | 2.0 | ------ | ----- | 123 | 1.9 | 285 | 8.6 | ------ | ----- | 65 | 4.0 | 323 | 3.4 | 241 | 6.2 | ------ | ----- | ------ | ----- | ------ | ----- | 249 | 10.3 | 291 | 8.8 |
| 5,000 | ------ | ----- | ------ | ----- | 85 | 3.7 | 275 | 8.3 | ------ | ----- | ------ | ----- | 298 | 3.6 | 247 | 7.3 | ------ | ----- | ------ | ----- | ------ | ----- | 258 | 8.9 | 292 | 8.5 |

[1] Navy stations.

TABLE 3.—*Maximum free air wind velocities (M. P. S.), for different sections of the United States based on pilot balloon observations during August 1938*

| Section | Surface to 2,500 meters (m. s. l.) | | | | | Between 2,500 and 5,000 meters (m. s. l.) | | | | | Above 5,000 meters (m. s. l.) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Maximum velocity | Direction | Altitude (m), m. s. l. | Date | Station | Maximum velocity | Direction | Altitude (m), m. s. l. | Date | Station | Maximum velocity | Direction | Altitude (m), m. s. l. | Date | Station |
| Northeast [1] | 29.8 | WNW | 2,260 | 11 | Newark, N. J. | 29.2 | WNW | 3,360 | 24 | Pittsburgh, Pa. | 33.6 | WSW | 9,380 | 1 | Cleveland, Ohio. |
| East-Central [2] | 26.6 | WNW | 2,250 | 24 | Washington, D. C. | 30.4 | NW | 3,330 | 24 | Washington, D. C. | 28.0 | N | 9,720 | 30 | Greensboro, N. C. |
| Southeast [3] | 22.6 | ESE | 1,180 | 10 | Key West, Fla. | 19.9 | WNW | 4,840 | 27 | Spartanburg, S. C. | 20.8 | E | 10,180 | 10 | Jacksonville, Fla. |
| North-Central [4] | 33.8 | SSW | 1,380 | 13 | Huron, S. Dak. | 34.8 | W | 3,720 | 19 | Huron, S. Dak. | 54.0 | WSW | 12,210 | 16 | Fargo, N. Dak. |
| Central [5] | 29.6 | SW | 1,300 | 19 | Omaha, Nebr. | 34.3 | WNW | 4,410 | 25 | Moline, Ill. | 36.0 | WSW | 9,720 | 19 | Omaha, Nebr. |
| South-Central [6] | 27.6 | ESE | 1,300 | 25 | Del Rio, Tex. | 23.1 | E | 3,530 | 24 | New Orleans, La. | 41.0 | WSW | 18,910 | 27 | Abilene, Tex. |
| Northwest [7] | 36.0 | S | 2,500 | 11 | Havre, Mont. | 69.8 | SSW | 2,660 | 11 | Havre, Mont. | 59.2 | W | 14,140 | 16 | Billings, Mont. |
| West-Central [8] | 26.6 | W | 2,290 | 21 | Cheyenne, Wyo. | 36.3 | W | 4,420 | 19 | Denver, Colo. | 64.5 | WSW | 24,750 | 4 | Redding, Calif. |
| Southwest [9] | 21.3 | S | 1,770 | 17 | Albuquerque, N. M. | 30.3 | SW | 3,540 | 13 | Las Vegas, Nev. | 54.0 | WSW | 20,340 | 3 | Las Vegas, Nev. |

[1] Maine, Vermont, New Hampshire, Massachusetts, Rhode, Island, Connecticut, New York, New Jersey, Pennsylvania, and northern Ohio.
[2] Delaware, Maryland, Virginia, West Virginia, southern Ohio, Kentucky, eastern Tennessee, and North Carolina.
[3] South Carolina, Georgia, Florida, and Alabama.
[4] Michigan, Wisconsin, Minnesota, North Dakota, and South Dakota.
[5] Indiana, Illinois, Iowa, Nebraska, Kansas, and Missouri.
[6] Mississippi, Arkansas, Louisiana, Oklahoma, Texas (except El Paso), and western Tennessee.
[7] Montana, Idaho, Washington, and Oregon.
[8] Wyoming, Colorado, Utah, northern Nevada, and northern California.
[9] Southern California, southern Nevada, Arizona, New Mexico, and extreme west Texas.